

of cane, leaving about 12 per cent fibre and 3 per cent of glucose and other foreign matter, and thus a balance of 5 per cent unaccounted for. The cane trash from the mill is conveyed automatically to the furnace room, and fed direct to the furnaces.

Steam is the motive power to drive the machinery, which is supplied through the agency of two flue and multi-tubular boilers. Some two years ago the mill was enlarged from a 5-roller to a 9-roller mill, the machinery being supplied by the Honolulu Iron Works of Honolulu. During the month of June the mill was running on the Yellow Bamboo or Whitney cane, and according to the statement of the manager the product that was then being run through the mill carried a greater sugar density than some of the Rose Bamboo.

The average rainfall at Niuli will be found interesting at this time, particularly as no rain of consequence fell in the Kohala district during the months of May and June: 1884, 57 69-100; 1885, 85 86-100; 1886, 49 92-100; 1887, 48 94-100; 1888, 46 32-100; 1889, 50 82-100; 1890, 96 65-100; 1891, 59 34-100; 1892, 38 12-100; 1893, 35 19-100; 1894, 51 19-100; 1895, 52 69-100; 1896, 43 50-100; 1897, 26 27-100; 1898, 51 75-100; 1899, 42 67-100; 1900, 46 36-100. The average rainfall for a period of fifteen years was 52 97-100 inches.

Mr. Robert Hall, the manager of this plantation, has followed the sugar industry on Hawaii since 1878, and since 1886 has managed its affairs.

Theo. H. Davies & Co. of Honolulu are the local agents.

Union Mill Co., Ltd.

Situated in the Kohala district of Hawaii are the holdings of the Union Mill Company, which comprise 2720 acres of land. Of this area 2300 acres are planted in cane, principally of the Rose Bamboo variety. Of this year's crop there are 505 acres of plant and 377 acres of ratoon cane, while the crop of 1902 will be 435 acres of plant and 234 acres of ratoons.

The first cane planted on the lands was twenty-eight years ago, the crop consisting mainly of the Lahaina cane and some little of the Cuban variety. The lowest elevation that cane is planted is 100 feet and the greatest altitude is 1600 feet.

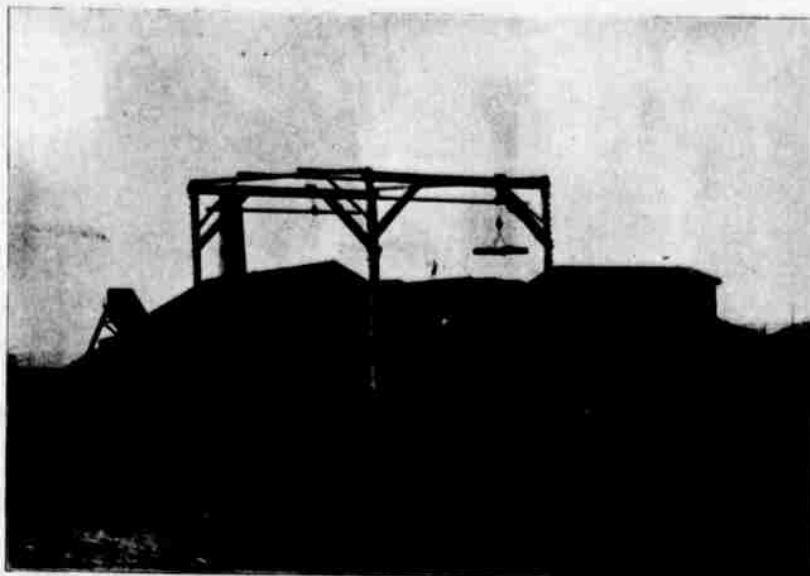
In the plowing of the soil the "Fowler steam tackle" is employed, which is described elsewhere in this report, while in some cases small pieces of land are plowed by disc plows. With the steam plows the soil is turned over to a depth of sixteen inches, while the disc plow turns the soil over to a depth of twelve inches, which is considered deep enough on the soil where the plows are used.

The average yield of all cane raised on this plantation is three tons of sugar to the acre, or twenty-six tons of cane to the same area. It is the aim of the management to strip the cane twice a year, while the method of conveying the ripened cane from the fields to the mill is by mule and bullock teams, the wagon having an average capacity of four tons.

The amount of high-grade fertilizer used on the soil is very light, being only 300 tons a year. The number of men employed in and around the plantation is 280, who are all paid by the month, there being no other system in vogue. Some eight miles of plantation roads have been constructed. One hundred and forty-five head of horses, mules and bullocks are necessary in hauling cane, plowing, etc.

As the cane arrives at the mill the load is removed from the wagons by the aid of an unloading station or derrick operated by an overhead traveling crane driven by steam power, and deposited by one movement direct to the cane carrier, from whence it passes first to a Smith cane cutter and thence to a modern nine-roller mill. No. 1 mill is 26x54 and is driven by an 80-horsepower Putnam engine, while Nos. 2 and 3 mills are 30x60 each and are driven by a 155-horsepower Hamilton-Corliss engine, while the combined hydraulic pressure on the mills Nos. 2 and 3 is 550 tons. The mill is supplied with the latest sugar-making appliances such as the Deming system of clarification, triple-effect, one 3 and one 2-ton vacuum pans, five mud presses, six 36-inch Weston centrifugals driven by two Weston engines and speeded up to 1200 revolutions a minute. Connected with the main engine room are the machine shops, where all repairing is done. Water to supply the mills is obtained by laying two and one-half miles of 14-inch pipe to the mountains, the supply necessary being obtained from springs. The water supply for the sugar-boiling house is obtained from a 6-inch well 432 feet in depth and pumped up by the aid of a 10-horsepower direct acting pump. The mill extraction compares favorably with other mills in the Kohala district, and is from 91 to 92 per cent, depending of course largely upon the fiber of the product. The molasses product from the cane is fed largely to the stock, while the cane residue or trash is conveyed from the mill by an endless carrier and fed direct to the furnaces by an automatic feeder. The capacity of the mill is 50 tons of sugar in twenty-four hours, but as the mill is only operated in the daytime the actual output is approximately twenty-five tons. The raw sugar, when sacked and ready for shipment, is conveyed by teams a distance of one mile and delivered to the Hawaiian Railroad Company, who convey it to Mahukona landing. The company, in order to develop a sufficient quantity of water for irrigation purposes, has commenced to sink a shaft 4x5 in the clear at a point 600 feet above sea level. By tests made by the company with drilling machines it is estimated that water will be encountered at the 150-foot level.

The Union Mill Company, Limited, is one of the oldest plantations on the island, and is conducted under the management of Jas.



Method of Hauling Cane and Delivering Same to Mill, Union Mill Co., Kohala

Renton, who has filled that position for twenty-three years and who is a practical sugar grower.

Following are the officers and attaches of the company.

Jas. Renton, President and General Manager.

H. H. Renton, Vice President and Secretary.

F. M. Swanzy, Treasurer.

W. P. McDougall, Head Overseer.

Theo. H. Davies & Co., Honolulu Agents.

Hawi Sugar Mill.

The Hawi is the most extensive plantation in the Kohala district, having a total area of 5271 acres, of which holding 2825 is land well adapted for the growing of sugar cane, while the balance is pasture land. The total area now in cane is 2350 acres, in which estimate are included 375 acres ready for planting, and 275 acres of fallowed land. Besides the above area there are some 300 acres of individual plantations. The crop for 1901, which has largely been milled, was 750 acres of plant and 491 acres of ratoons, while the estimated crop for 1902 is 468 acres of plant, 416 acres of ratoons, in addition to which there are approximately 210 acres of cane on the Puakea plantation.

The first cane planted upon the Hawi plantation was twenty-five years ago, and consisted principally of the Lahaina and a limited amount of the Cuban variety. At present the principal varieties grown consist of the Rose Bamboo, Yellow Caledonia, Lahaina and some of the Yellow Bamboo or Whitney cane.

The method of conveying the cane from field to mill is performed by the aid of wagons drawn by mules and bullocks, and also by a traction engine, the wagons having a capacity for holding each an average of four and three-fourth tons. In the plowing of the soil "Fowler's steam tackle" is used where it is possible to do so, but upon steep hill-sides and limited areas the ordinary plow and mules are found effective. About fifteen miles of road have been constructed, affording access to the various cane fields for expediting the delivering of seed, fertilizers, etc.

In the cultivation of the soil very little fertilizer is used, as it is found, according to the statement of the manager, that fertilized cane will not stand the periodical droughts as well as the unfertilized ground. In the cultivation of the soil the secretory disc plows and planter junior cultivators are used, while all labor upon the plantation is carried on by day labor, there being at present 270 names on the pay roll.

The lowest elevation that cane is planted is 200 feet, while the greatest altitude is 1300 feet. It is the aim of the management to strip the cane at least once during the growing of the crop, but owing to the

scarcity of labor it has been found impracticable to do so this year.

Of late considerable attention has been given to the development of water for irrigation purposes, and any information bearing upon that an important question will be found interesting. The rainfall at the Hawi plantation for a period of 11 years is as follows: 1890, 74.38; 1891, 59.06; 1892, 40.58; 1893, 37.07; 1894, 53.48; 1895, 54.24; 1896, 39.99; 1897, 27.21; 1898, 49.19; 1899, 39.73; 1900, 40.65. The average rainfall for the eleven years was about 48 inches, while for six months of 1901 up to June 1st was 26.93, of which precipitation 12 inches fell during the month of March alone.

To John Hind, manager of this plantation, is owing the credit of developing the first water by the aid of shaft and tunnel work on the island of Hawaii. In this way he obtained a pumping supply of 1,000,000 gallons in twenty-four hours, which, under favorable conditions, will irrigate 200 acres. This well is ninety feet in depth, at the bottom of which has been installed a compound Worthington pump, which raises the water to the surface, where a triple-expansion Worthington pumping system has been placed, which lifts the water 360 feet higher to concrete reservoirs.

In addition, at a point 70 feet above sea level, a still greater supply has been developed, where has been installed a 4,000,000 gallon Risdon condensing high-duty pumping system, which lifts the water to a height of 300 feet to the reservoirs, from whence it is utilized. In the operation of both of the pumping systems steam is the motive power, which is produced through the use of Heine safety water tube boilers.

At the present time the new pumping system is throwing nearly 2,000,000 gallons in twenty-four hours, but the work of driving more drifts and developing a greater supply of water is being proceeded with.

The main engine is a Cross compound condensing Corliss engine. This same engine operates a deep-well pump proper, being installed at the bottom of the pit, which is seventy feet in depth. This pump lifts the water to a reservoir on the surface, from which the main pump on the surface receives its supply.

This method of operating deep-well pumps is the first of its kind in use in the Hawaiian Islands, although many such plants have been erected and are in successful operation throughout the Pacific Coast. By this method the large underground chambers are done away with and all the operating machinery is upon the surface and within easy access of the engineer.

The plant has been in successful operation for a year, and this method of pump installation underground has proven successful.

At a point 260 feet above the pumping system and at the highest point upon the land irrigate, have been erected three large concrete reservoirs having a joint capacity for holding 1,250,000 gallons. These reservoirs are filled at night from pumping



Cane Fields and Mill, Honomu Sugar Co., Island of Hawaii

station No. 1, and drawn upon the following day.

The yield of sugar per acre of cane for 1901, which includes the cane of outside planters, will average two and one-fourth tons from unirrigated cane; for 1900 the average for the whole season was nearly five tons to the acre, and with seventy-five inches of rain fairly well distributed throughout the year, the yield would not fall below four tons of sugar to the acre. In a distance of a mile apart and upon the same plantation the variation of rainfall in some years will be fully 30 per cent.

In order to expedite plowing operations the manager has constructed a 14-disc plow which is operated with the Fowler tackle described elsewhere and performs the work of plowing the ground for a width of fifteen feet by a single trip between the location of the two cable engines, and thoroughly pulverizes and mulches the soil for second, or cross-plowing.

The method of unloading the cane at the mill is simple and effective, the wagons coming up alongside of the endless cane carrier under a derrick and overhead traveling crab system, and the entire load of cane is hooked onto by a series of suspended hooks and iron chains and alings, and delivered direct to the cane carrier. The raising of the load from wagons to carrier is controlled by a cable and steam drum and is a very effective method of handling the product.

The cane is fed by the carrier to a National shredder, which places the cane in proper condition for securing the best possible mill extraction, which is given as 91 per cent of the sucrose contents of the cane, varying of course according to the fiber and the general condition of the plantation product.

The grinding of the cane is performed by aid of two 3-roller mills operated by two separate engines, while connected with the engine rooms are machine shops for general repair work.

The mill is supplied with three clarifiers, three precipitators, two 6-ft vacuum pans having a combined capacity of six tons of dried sugar besides standard quadruple effects, six mud presses, six 30-inch centrifugals operated by separate engine, and driven up to 1200 revolutions a minute, one Hersey granulator or sugar dryer, and other sugar machinery and appliances.

The trash or residue emanating from the mills is conveyed by an endless carrier to the furnace room and fed direct to the furnaces by the aid of the "Yankee fireman" feeder.

The mill has an average capacity equal to twenty tons of raw sugar in a day of ten hours and turns out two grades designated as Nos. A and B, while the sugar output for the season of 1901 will be 3200 tons.

From the sugar floor in the mill the sacked sugar is conveyed to Honolulu at which point the company own their own landing, warehouses, etc., which is distant four and one-fourth miles from the mill, and from where all sugar is shipped and freight for the plantation received. The method of conveying the sugar product is by a series of wagons drawn by a traction engine, and hauling thirty tons of sugar in a single trip and returning with fifteen tons of general freight. The time consumed in making a round trip is five hours, and by making two trips in a day or ten hours, which can easily be done, the cost of operation, including fuel and labor incident thereto, is given as less than fifteen cents per ton. The cost of loading from warehouse at landing to vessel, including labor, fuel for boilers, oils for engine and machinery and general maintenance of the landing, is forty cents per ton.

At the landing the company have large coal bunkers capable of holding a thousand tons, the majority of which supply is consumed in operating the two pumping plants and steam plows. This coal is landed from the vessels and delivered into the coal bins for 12 cents per ton.

The company also have warehouses capable of holding 1300 tons, and the method of loading the vessels with sugar is by a direct loading cable system, whereby 345 tons of sugar have been placed aboard the vessels in a day of ten hours, the average being 300 tons, while the usual day's work for unloading freight is 125 tons in a day of ten hours. This is the first cable transporting system introduced on the island of Hawaii, and outside of Mahukona this is the only landing in the Kohala district. At the present time between 6000 and 8000 tons of sugar and general plantation supplies are handled at this landing in a year. The above plantation is owned by Robert H. Hind, and for the past twenty years has been conducted under the successful management of John Hind.

Hind, Ralph & Co., Honolulu, are the general agents for this plantation, as likewise the Puako, located at Kawaihae.

Hawaii Railroad Co.

The above railway system, operating between Mahukona and Niuli, was originally constructed by S. G. Wilder, and was first operated in 1881-82 under a contract with the sugar plantations in the Kohala district, whereby the owner of the road agreed to keep the mills free from sugar.

Some time ago the entire plant was acquired by the owners of the Union, Kohala, Halawa and Niuli plantations, who absolutely own and control the road.

The road is twenty miles in length, constructed on a 3-foot gauge and laid its entire length with 35-pound rails. The road is equipped with seventy-five freight and passenger coaches and four locomotives. The principal business of the road is the shipping in of coal and general supplies for the plantations and the taking away of sugar for the Mainland and Europe.

The company charter a line of vessels